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Meal Feeding and Animal Digestion,

A TEXT BOOK FOR ALL WHO FEED CONDENSED FOOD.

By LINUS W. MILLER,

Author of Notes of an Exile, Design of Creation.

Published by request of the AMERICAN DAIRYMEN'S ASSOCIATION, before whom it was delivered March 14, 1875.

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Meal Feeding and Animal Digestion.

AN ADDRESS

DELIVERED BEFORE THE ANNUAL MEETING OF THE CRAWFORD COUNTY DAIRYMEN'S ASSOCIATION, AT MEADVILLE, PA., JANUARY, 1875.

ALSO

BEFORE THE TENTH ANNUAL CONVENTION OF THE AMERICAN DAIRYMEN'S ASSOCIATION, AT UTICA, NEW YORK, JANUARY 14, (WHICH CONVENTION, BY RESOLUTION, REQUESTED THE AUTHOR TO PUBLISH IT IN PAMPHLET FORM).

WITH AN ADDENDUM, GIVING INSTRUCTIONS FOR THE PRACTICAL APPLICATION OF THE PRINCIPLES ELUCIDATED.

Containing also tables of equivalents, and analyses of coarse and fine food, by the most reliable authorities.

A Text Book for all who feed Condensed Food.

BY LINUS W. MILLER.

(Author of Notes of an Exile, on Canada, England, and Van Dieman's Land, Design of Creation, etc.)

DE PROFUNDIS.

STOCKTON, NEW YORK, *January* 5, 1875.

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S.S.C. Apr. 9, 12

PREFACE.

PERFECTION, in a work of this nature, should not be expected. The adoption of a new practice, so utterly at variance with established usage, not for centuries only, but the whole history of our race, in feeding the order of animals classed as ruminantia, concentrated food *alone*, involves very many grave considerations, which require the test of longer experience, and more extended and rigid observation and investigation, than the author can lay claim to. Forty-two months, at detached intervals, is the extent of that experience : and even while thus engaged, the thought of writing a treatise for the guidance and instruction of others never found a place in his imagination. He knew, after his first experiment in meal feeding, that old theories were false ; but the extent of his ambition has been, to discover by close investigation and study, the true theory of digestion, and its application to condensed food. Time alone will determine whether condensed food, fed for consecutive winters, is safe and advantageous to practice. The author's mind is clear, that so far as his tests extend, they are *demonstrations*. "Out of the depths" has grown the *solid rock*, and on it he humbly stands, in these hastily written pages, and points to FACTS, to which all theories must conform, as his justification for offering so imperfect a treatise, upon a subject of such vast importance, to an intelligent Public.

INTRODUCTION.

MILLIONS of dollars are undoubtedly wasted every year, both in this country and Europe, by injudicious feeding of concentrated food to our domestic animals. This assertion may perhaps be deemed extravagant, by the advocates of the old theories; but time alone is needed to demonstrate its truth.

A better understanding of the digestive powers and capacities of our ruminating stock, and the adaptation of certain kinds of food to produce certain results, alone is needed to work a revolution in our whole management of feeding, not dairy-stock alone for a few winter weeks, as some have supposed, but in the use of fine food at all times and under all circumstances. Every man who feeds for the production of beef, keeps a dairy or a single cow, in town, city or country, should understand the general principles of animal digestion, as he is liable to throw away his money without knowing it.

He who attentively studies the principles of this unpretending work, will need no apology from the author for the importance which he attaches to it; and he who, from whatever cause, chooses to follow the old beaten track of his fathers, as it is his undoubted right to do, has no business to exact any. *Ridicule* and *abuse, without stint,* have not been withheld hitherto; but Truth has nothing to fear; if put down *to-day,* there will be a resurrection *to-morrow.* Right will triumph in the end over all opposition. The intense interest manifested

both at Meadville and Utica upon this subject of meal feeding, where large numbers of earnest practical men from various sections were congregated, and their acquiescence in the general principles laid down in the Address, is a guaranty of the ripeness of the public mind for the reception of truth, no matter what may become of old theories. "This would have saved me *one thousand dollars* last winter, had I known and practised it," was said to the author by three different persons after the reading of the Address; while scores named smaller sums, ranging from one hundred dollars upwards, as the measure of benefit which it would have conferred upon them. When, in addition to the exigencies of short hay crops, we take into consideration the daily waste of meal and other fine food, at all seasons of every year, in the production of milk and beef, the magnitude of the interest involved in the aggregate is astounding! Certainly, it is high time that this question is better understood. Personal considerations are of little moment, when such general interests are weighed in the balance; but the author claims the right to say, in this connection, that if in error as regards the application of any of the principles laid down in this little work, no one can mourn so deeply as himself. The world is full enough of error and false theories already; and his chief ambition is to bear some humble part in their correction.

The criticisms and strictures which have appeared in the agricultural and secular press of the country during the past season with reference to "*feeding meal alone*" if collated would comprise quite a volume; and would be chiefly interesting as showing the want of correct knowledge as to the real principles involved, and the absurdities of the old theory as based upon *bulk* and woody fibre. From a mass of strictures, in some of which

threats of prosecution under the statute to prevent cruelty to animals is directly hinted, two or three of the most moderate are herewith given as a matter of history.

NEVER FEED MEAL ALONE.

Fine meal, we know, is much more valuable than coarse meal, but farmers do not reach the true reason for the disturbance in the digestive system of the cow from feeding coarse meal. The scouring is caused by feeding the meal alone or unmixed with hay or other coarse food, which would carry it to the first stomach. When meal is fed alone it goes directly to the fourth or digesting stomach, and not having had the macerating process of the first stomach and re-mastication and mixed with saliva, it is not in a fit condition for the action of the fourth stomach, and will cause scouring, whether fine or coarse, although very fine meal will cause less disturbance than coarse, because the finer particles are more easily dissolved by the digesting fluid, and thus more readily assimilated ; but nature intended all the food of ruminating animals to have the macerating process of the whole series of stomachs.

FEEDING MEAL TO COWS.

Eds. Country Gentleman :

In your last issue (*March 19th*) READER, in his article on winter feed for cows, makes the following assertion : HARRIS LEWIS gravely informed the people of this country that "all the meal they were feeding to cows was being thrown away." This may be a correct quotation from some one of the published reports, and it may be what I said. I would ask Reader, however, if I did not say that I believed the dairymen of Chautauqua county were feeding corn meal at a loss, and that much of it was thrown away? I am ready to accept Reader's under-

standing of what I did say, and will not deny anything people charge me with.

Reader then goes on to state what the farmers are going to determine the relative value of different kinds of feed for wintering dairy cows. This is just the thing I have often urged dairymen to do, and I rejoice that any man has the independence to step out of the beaten track, as Mr. L. W. Miller has done in this matter. I also rejoice that Reader has opened his eyes to some rays of light which have changed his opinions, similar to those of mine, which he used to 'hold in regard to the value of corn meal and corn fodder for cows.

If Mr. Miller's experiments with corn meal do not put his profits for the coming season, and his cows, also, in about the same predicament that the dairymaid's chickens were in when counted so long before being hatched, I shall again rejoice. If Mr. Miller's corn meal diet proves just the food for dairy cows, it will settle one thing forever, viz., that the very best corn lands are above all others *the* lands for dairying, for we cannot on the best grass lands in the United States, north or south, east or west, keep dairy cows for six and a quarter cents per day, on grass or hay, or both, the year through. The cost of keeping a dairy cow at the west, on ten cent corn meal, would be so near nothing that it would be hardly worth naming. If I can keep a dairy cow well on corn meal, I will sell or give away my grass farm, and *go west.*

HARRIS LEWIS.

THE MEAL THEORY.

The meal theory of L. W. Miller of Stockton, by a correspondent of *Country Gentleman* is hit off as follows: "I have known a cow to increase in milk by feeding a moderate quantity of Indian meal at regular periods,

in addition to other food. But when you talk of feeding a cow three pints of dry meal in the morning, and three pints at night, and no other fodder, "with very little" water, of course there must be some screw loose in the statement. Why, there are some *men* who would use about as much food as that. The six pints would weigh about five pounds (the actual weight is about *four* pounds). Indian meal has about 66 per cent. of fat forming food and 11 per cent. of muscle forming substance. Good hay has about 36 per cent. of the former, and 13 per cent. of the latter. Ten pounds of good hay would be more than equal to the six pints of meal. Yet who ever heard of keeping a good cow on ten pounds daily of hay!—to say nothing of the "very little" water!

FEEDING MEAL.

The Utica *Herald* notices the report of the experiment being made by Linus W. Miller of Stockton, on feeding meal alone, and accompanies the report with the following remarks :

The feeding of finely ground corn meal to dairy cows is now being widely considered. Dairymen in this region are now feeding more meal than ever before. The question to be determined is, whether this nutritive material is in a form unsuited to the full exercise of the digestive functions, and consequently, likely to waste its nourishing qualities through imperfect digestion. That it is an unnatural food, that it slips untouched through part of the digestive machinery of the animal, is claimed by some of our most intelligent dairymen. On the other hand, there are many men who feed meal, and think they do so with profit and with good results to the animal.

We are glad that Mr. Miller is making the experiment

which is described above. We have little faith in his proving that meal is a perfect and sufficient food; for if his cows maintain their bodies on meal alone, they will perform several creative acts, and creation is not vested in the animal economy. There are materials in the tissues of the body which do not exist in corn meal.* They are not present in it in any shape nor form, consequently the transforming power of the animal cannot act, for it has no material to work over. Again, Mr. Miller is operating in the face of well established beliefs, that a single food is not suitable for maintaining the health and strength of the animal for any great length of time. That Mr. Miller has so far proceeded in his war against nature, that he has succeeded in doing away with rumination in his herd, will startle those who believe in the strict utility of natural processes. But though we are forced to sympathize with Mr. Miller's cows, we hope he will pursue his experiment to the end. We have almost as little faith in his success as in anything we might mention. Feeding meal alone is very different from feeding meal together with more diffuse food. We believe that meal fed properly will do good service, imparting richness to the product and fullness to the form, but a food which leads the cow to forget the cunning of her natural machinery, must seem at the outset to be prejudicial to health and profitable increase. Nevertheless we shall watch Mr. Miller's progress with much interest and attention.

MEAL ONLY FOR COWS.

Eds. Country Gentleman:

I observe that the statement of Mr. L. W. Miller relative to the keeping cows on meal alone, is attracting

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* What are they?—AUTHOR.

some attention, and deservedly so. I cannot help regretting that so preposterously absurd an idea, as that cattle can be maintained in health for months together, on nothing but a few quarts of corn meal a day, should be put forth as worthy of trial. The stomach of the bovine is intended by nature to receive a large mass of moderately nutritious food, and it is only when it is properly filled, that the animal can experience the sensation of comfort so essential to health. If Mr. Miller will try the experiment on himself, being contented with three meals a day, each to consist of a single meat lozenge or a teaspoonful of concentrated beef tea, he will experience much the same sensations as his unfortunate cows. * I cannot, however, regard the statement as anything but a hoax. Any one accustomed to cattle knows, that the excessive use of meal invariably results in diarrhœa or dysentery, if long persisted in ; and that unless a proper proportion of coarse feed, such as hay, straw, or grass is used, the health of the animal is sure to give way. I think the statement in question will be accepted by none but "the marines."

L. B. L.

Sherbrooke, P. Q., Canada.

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* Mr. Miller, along with about ninety other political prisoners, for the offense of trying to give a responsible government to his friends in Canada, suffered the *gnawings* of hunger on a *very empty* stomach for years, in Van Dieman's Land, under *British* rule ; and he can tell L. B. L. a tale of horrible suffering, *usurpation*, and *cruelty*, that should make a *savage blush* for *shame!* Mr. Miller has no taste for starving even *dumb animals*, much less his fellow men; and if L. B. L. had ever suffered a little of what those unfortunate prisoners endured, he would not wonder, nor take any exceptions, to the severity of this note.

MEAL FEEDING AND ANIMAL DIGESTION.

GENTLEMEN OF THE AMERICAN DAIRYMEN'S ASSOCIATION:

I shall confine my remarks mostly to feeding Indian meal to dairy stock, when dry, and to their digestion of coarse and fine food. Certain practices of my own in wintering my cows, having attracted much attention and not a little criticism, I suppose you will expect me to explain those practices. Sixteen years ago, happening to mention to a gentleman of my acquaintance that I was short of hay for wintering my stock, he informed me that he had wintered his cow upon three pints of scalded meal, keeping in stall all winter, and watering by hand, and he assured me she came through in good condition, and yielded a fair product of milk that season. Seizing upon this hint of my friend I ventured to place my herd of twenty cows, having first dried them off, upon an exclusive meal diet, feeding an average of three pints, dry, morning and evening, giving the large cows a little more, and the small ones a little less; keeping them in warm, clean, properly ventilated stables, and only turning them out one-half hour each day for water. They were uneasy the first three or four days of meal diet; but after that had the appearance of unusual quiet and content. I am confident their rations were ample to satisfy the wants of nature, and that they did not lose flesh. The experiment would have been more valuable if they could have been weighed at the commencement and end of meal feeding.

In the spring, when they began to drop their calves, I fed them all the hay they would eat in the morning and two quarts of meal at night. But they showed a decided preference for meal over hay. The calves dropped were of the usual size, strong and healthy and gave no indication of a deficiency of proper and essential elements in the food of the mother. When upon exclusive meal diet —a period of nine weeks that season—rumination ceased when they had no longer any food to remasticate. Occasionally one would refuse her meal. It was my custom to administer a tablespoonful of dissolved coperas on such occasions, and a restoration of appetite followed. When the weather was very stormy they were kept in and supplied with water by hand. The amount of water drank at such times was surprisingly small, varying from one quart, in rare cases, to eight or ten per cow each day. I think they would not average to exceed five quarts. Although accustomed to eating a daily ration of salt during the summer, they showed but little inclination to eat it on meal. But when again fed upon hay they at once resumed consuming the usual quantities of water and salt. I made more than the usual quantity of spring butter that season, and when turned out to grass, my cows did better than I had ever known them before, when wintered in the usual way.

After this experience, whenever short of hay, I resorted to meal, feeding in as many winters, five, seven and eight weeks and always with the most satisfactory results; my cows when turned out to grass invariably doing better than when wintered on hay, both as to quality of milk and a tendency to lay on flesh. In the season of 1873–4 my hay crop was unusually short, and what corn fodder I had was badly damaged by frost, feeding which, in early winter, my stock were in unusually poor flesh when I commenced feeding meal on the 1st of January.

The result of my experiment I condense from a communication over my signature, published in the Chautauqua *Farmer* in August last.

"The records of the factory where I send my milk, show an aggregate of 531 cows. There are three herds of cows giving as much, or more than my own the present season—one of them nearly two pounds more daily ; but the last sale of cheese of which I have a record, being the make of sixteen days, from June 10th to 26th, credits my herd with giving two pounds fifteen ounces each per diem more than the average of the whole 531. My herd was selected with reference to making butter, not cheese, and I have never regarded them as great milkers ; they averaged twenty-seven pounds per diem, for the sixteen days' sale.

"In 1872–'73, I wintered my herd upon hay. They came through in good condition, and were fed during the spring months, with two quarts of meal daily, and all the hay they would eat. In 1873–'74 I fed for nine weeks (while dry) three quarts of meal ; then what hay they would eat and two quarts of meal, for three weeks ; then bean vines and meal, for two weeks, losing one of my best cows in the operation of feeding bean vines, and setting the whole herd scouring badly and losing flesh. Then I did what I have never done before to cows giving milk. I fed during the rest of the spring before turning out to pasture, on clear meal, a period of about five weeks, giving five quarts of wet meal daily to those giving milk. Under this treatment they did well, and although the flow of milk was less than when fed on hay, its quality was excellent, and the butter superior. The bean vine butter, however, was poor.

I find, by the factory records, that my cows are giving five pounds of milk each, per diem, more than they gave during the corresponding period last season, when win-

tered on hay. But with this difference in their treatment. This season my hill pasture has been very short during the entire season thus far, although I am carrying four head of stock less than last year, and I have in consequence fed about three quarts of dry bran, per head, to my herd daily. I do not think, however, that this bran would make up the deficiency in pasture as compared with last season.

I fed, last winter, white western meal instead of yellow native corn of my own growing, as heretofore. White Indian corn contains only a fraction of one per cent. of oil, while yellow contains nearly four per cent. There was a marked difference in its effects from anything I have ever seen while feeding yellow meal. The hair first began to look and feel stiff and harsh, then the skin became dry, with the appearance of scurvy, after about six weeks feeding ; and finally some of the herd actually broke out with small blotches along the back and sides. I understood perfectly well that a small quantity of linseed oil cake, fed with the meal, would correct all this, and make white meal equal to yellow; but the eyes of the whole country were upon me, predicting failure, ruin and starvation to my cows, and I chose to run the risk of consequences, without any variation from what was advertised ; but I shall never feed white meal exclusively again, without adding to it something to supply the deficiency of oil. Hereafter I intend to winter my cows, when dry, upon meal, when I can get it, in preference to hay."

At the close of the season, having fed no bran or extra feed since the 20th of August, I find, by factory returns, that my cows averaged a fraction less than 20 pounds per diem for the season of five months—May 19 to October 19—being 1 pound 3 ounces each, per diem, more than the average of the 531 cows whose milk was sent to the factory, and an average of four and a

quarter pounds each per diem more than my cows gave for the corresponding season, the previous year, when wintered on hay. I had also two cases of abortion in my herd—the result of accidents—having but one the previous year. The conditions were more than ordinarily unfavorable; but the results were, to say the least, a demonstration of the adaptation of an exclusive meal diet to meet the wants of my animals under the conditions enumerated. Another result of meal feeding I find to be a tendency to lay on flesh more readily than when wintered in the usual manner. I am also satisfied that my herd hold their age better, and that their teeth last longer; the reasons for which are apparent. What the effect would be if wintered continuously for consecutive years on condensed food I am not able to say, never having tested it. But looking to my own profit, as a dairyman, I propose hereafter to feed my cows when dry upon an exclusive meal diet, and also to feed more freely on this article during the spring months. My practice has been to make the change from hay to meal and *vice versa* suddenly without gradation, and thus far it has been with safety; yet prudence might dictate a gradual change when returning to hay; and also care in supplying the animal with the necessary quantity of water for moistening the coarse food. If cows could be watered in their stalls, whether fed on meal or hay, in cold weather, and their stables kept warm and clean, taking care to curry daily; at such times, there would be a great saving in food. I would not wish to be understood as laying down the rule that a daily ration of three quarts of meal is sufficient in all cases. Large cattle would require more, and small less. He who feeds meal exclusively should watch his animals closely, and variations be made in the quantity according to circumstances. In very cold weather the animal requires more

food, no matter what its nature may be, than in warm pleasant days. The practice of turning out animals in the cold and storms to become chilly, is neither humane nor economical. Regularity in the hour of feeding is also of great importance, whatever the food. It is a law of animal life that the appetite conforms to habit, and that the digestion of food will be more perfect if taken at stated intervals. Where food of any kind is kept constantly within reach of an animal, it is tempted to eat more than nature requires, and much more than can be properly digested. In feeding meal, whether alone or diluted with coarse food, it is absolutely imperative that it should be ground as fine as for family use ; and if from white corn, on an exclusive meal diet, a small quantity of oil meal or cotton seed meal should be mixed with it.

As to the economy of meal feeding, much depends upon the respective prices of corn and hay. The present season corn is high, and hay can be had at a reasonable figure ; but when the conditions are reversed, the balance sheet, leaving out the question of increased products, is decidedly in favor of meal. Our farming lands should average fifty bushels of corn to the acre, and our meadows two tons of hay in ordinary seasons. One bushel of corn should last an average sized cow twelve days, when dry. Fifty bushels should keep twenty cows thirty days, where the product of an acre in hay would barely suffice for ten days. The question of labor would vary the result, as well as the value of the manure. I do not claim the facts which I have related as a complete demonstration of the superiority of meal over hay for winter feeding of dairy stock. The known difference in the product of cows in different seasons, without any perceptible cause, renders all detached experiments to a certain extent unreliable. When, however, whole herds show an increased product, it is safe to attribute the

change to the causes specified. An experimental farm, like those so ably conducted in Germany, where careful experiments could be conducted for a series of years, testing the relative value of all kinds of food for the production of milk, and the accumulation of flesh and various other desiderata is much to be desired. Nevertheless some propositions have been proved, and some theories exploded, which were regarded as axioms only one year ago ; as that rumination is not essential to health in the ruminantia ; that it is only natural when made necessary from feeding coarse food ; that condensed food may be fed profitably, and in perfect harmony with nature's laws, without being diluted with coarse food ; that *bulk* in food is not advantageous, but the contrary ; that nutriment in food, and not bulk, governs the condition and health of the animal ; and that condensation of nutriment, and not expansion, is true economy.

Following in the track of this advanced step, are results of vast importance to the dairying interests of the world. The terror of short hay crops, and famine prices, are among the things of the past. By planting more corn, we can keep more cows on our farms ; and our brethren in the great corn growing regions of the west, may confidently anticipate an increased demand, and enhanced price for their great staple product. A few remarks upon the digestion of ruminants, and I have done.

Gentlemen, nature has made no mistakes. Her laws are the perfection of wisdom. Design is inscribed in characters of living light upon all her varied pages. The primitive rocks, not less than alluvial soils, bear the stamp of royal laws, harmoniously working out the great problem of existence. The lowest forms of vegetable and animal life are but links of the great chain, stretching from the Silurian periods down through interminable ages to the present day. Adaptation to surrounding circum-

stances, and to the exigencies of life, are clearly discernible, in every phase and grade of the animal and vegetable kingdoms. A creature of such vast importance to man as the ruminant, would be an exception in nature, placed, as she is, in latitudes where malignant and blighting frosts, and drouths, so frequently cut short vegetation, if she was not fitted to live and thrive, in spite of such adverse surroundings. Her four stomachs are a wonderful adaptation to her wants and necessities under different conditions. In the calf, living upon its mother's milk, we find no development of the stomachs used upon coarse food. This fact is important, as showing that concentrated food is not unnatural to the ruminant; complete digestion and assimilation certainly takes place; proving that all the conditions of life are fulfilled in this order of animals, independent of the use and functions of the 1st, 2d and 3d stomachs. This completely refutes the doctrine, so prominently advocated, that meal is an unnatural food, because it does not, when fed, pass through all the stomachs of the ruminant. Pardon the digression, in remarking, in this connection, that calves should never be suddenly weaned, but the change from milk, or concentrated food, to grass should be gradual; giving time for the gradual development of the necessary machinery for preparing grass, and other coarse food, for digestion and assimilation.

In the full developed ruminant we find grass, hay and all coarse food, after slight mastication in the mouth, passing into the œsophagean canal or passage, on the floor or bottom of which are two doors or openings, the first of which receives all coarse food, and as much water, when the animal drinks, as is required to moisten it. This opens into the first stomach or paunch, which is, so to speak, the animal's storehouse; and which, when herbage is abundant, she soon fills, and is prepared, or rather

inclined, from its bulk and weight, to lie down and at leisure finish the work which the non ruminant is compelled to do as it eats. This storehouse has an opening into the reticulum or second stomach, and by muscular action forces, in small quantities, its contents into it, where, also by muscular force, it is formed into pellets or cuds, and forced through a valve which opens upward, (but never downward) into the œsophagean canal; where, by muscular action, it is forced back to the mouth. Here, at its leisure, the animal remasticates it until it becomes so softened and pulverized, that in the second act of swallowing, it passes the first opening, or door, where, in its coarser state, it forced its passage before ; passes the door of the second stomach, which is always closed to food in its downward passage, and enters near the termination of the œsophagean canal, the door of the third stomach. Thus far the food has been only chewed and softened ; but here it is ground. Duplicatures, of the coatings of the stomach are here suspended from the œsophagus, which seize upon the food as it enters, and by muscular action, file and grind all the coarse parts so that nothing solid or fibrous escapes them.

From the third it passes directly to the fourth stomach, where true digestion begins. The gastric juice here secreted has the power of converting it into a mass called chyme, from which it is changed to chyle. The action of the digestive juices and glands in converting it into milk, blood, and from blood into fat, flesh, bone, muscles, hair, etc., has as yet never been satisfactorily demonstrated.

Modern investigations go to show, however, that only chemical changes take essential place in the food, or the elements composing it, but rather a mechanical change, disintegrating such substances or compounds as the animal's wants require, leaving that which is worthless to be

expelled: and that not only ruminants but the whole animal kingdom, are endowed by nature with organs, whose office it is to seize upon the elements required, generally, but not always, in solution in the form of chyle or blood, and with unerring certainty convey them to their destination.

In other words we say nature is conservative of her forces; and in the great chain of life, stretching from the lowest vegetable growth up to man, she appropriates, with the least possible change, the material of the lower to build up and perfect the higher. It is true that nature's laboratory is immense, and her power unlimited, but for that reason we must not charge her with being wasteful. Even cellulose (excepting crude) is not destroyed, but passing through the process of digestion is found deposited in the frame of the eater just, or at least nearly, as it was before mastication in the article of food.

Gentlemen, nature furnishes, in this respect, a pattern for man to follow. Let the dairyman do it and he will get rich. In considering the question of digestion, its proportions are of such magnitude as to forbid any attempt at even a cursory glance at its details in extenso, in this essay. I desire, however, for the purposes which I have in view, to call your attention to certain general principles involved in the subject of meal feeding, as an exclusive diet, under certain conditions, versus hay. In pushing our inquiry in this direction, we are met at the threshold with certain difficulties in the nature of the animal. For instance, the capacity of our cows to consume any given kind of food materially varies. Cows of equal weight will seldom eat an equal quantity of food. When they do its effects vary and are far from uniform. When the cow gives milk, we find in those of equal weight and size an astonishing variation in both quality and quantity of milk product. One will give four gallons

milk per day, and the other but two gallons. The milk of one may be rich in oily matters, and the other may be rich in caseine. In other words, there is a marked difference in the proportion of its constituents. Make the milk into butter separately, and we find a difference in color, flavor, and perhaps texture, as well as quantity. If equal quantities of each cow's milk from equal amounts of food were analyzed we should, perhaps, find the result from one as follows. I take, at random, an analysis of milk by J. Alfred Wanklyn :

IN 100 CUBIC CENTIMETRES.

Water,	88.43	grammes.
Fat,	4.12	"
Caseine,	5.16	"
Milk Sugar,	4.43	"
Ash,	0.76	"
	102.90	

From the other :

Water,	90.09	grammes.
Fat,	3.16	"
Caseine,	4.16	"
Milk Sugar,	4.76	"
Ash,	0.73	"
	102.90.	

Both being the product of the same food in quality and quantity, but from different cows, this conclusion is forced upon us.

1st. As to difference in quantity of milk. The mammary glands of one must have double the capacity of secreting milk which are possessed by the other ; or the stomachs of the latter must be sadly out of repair and incapable of performing their normal functions. Upon the last supposition, an analysis of the excrements, solid

and liquid, would probably fix the responsibility where it belongs. But we daily find greater discrepancies in the product of cows equally healthful; and we are compelled to look for the cause in the secretive glands of the animal. But the amount of food being the same, we have a right to look for the ingredients of two gallons of milk, stored away in the body of the defaulting animal, and shall not be disappointed, unless there is a want of capacity in her secretive glands to appropriate them. That such is the real case, I think no intelligent dairy-man, who has given his attention to the subject, will deny. The difference in condition of our good and poor milkers at the end of the season, will not account for the great deficiency of milk. At any rate we do not find its equivalent stored away in the form of fat or flesh. The poor milker is generally in the best store condition, but she ought to be much better than we are accustomed to find her. If we could analyze her excrements, we should probably find the missing constituents.

2d. As to difference in quality; the same course of argument followed out, forces upon us the conviction, that there is a marked difference in the capacity of the lacteal glands in the two animals to secrete the same constituents.

The difference in the fattening qualities of different animals of the same breed, as well as of different breeds, are additional facts pointing in the same direction, and forcing upon us this conclusion, viz: There is a limit to the capacity of each animal to appropriate the nutritive elements of its food. Hence, if food, we will say meal, is taken into the fourth stomach, in quantities larger than the various organs of digestion are capable of appropriating its constituents, the surplus is crowded out with the excrements and are lost. An analysis of the manures, solid and liquid, would determine the amount of waste, in

any given case. That meal, fed in large quantities at one time, is partially lost, except as manure, is evident; and this accords with the experience of many dairymen who having thus wasted it, come to the hasty conclusion that meal is of little value for food, and that three quarts per diem would be wholly inadequate to supply the wants of an animal.

The gentleman referred to in my opening remarks, as wintering his cow upon three pints scalded meal per day, wintered her the same season that I commenced this practice, upon three quarts; and he informed me she never did better in her milk product than in the following season. Last winter he fed three quarts meal and a small bundle of cornstalks, daily, milking her all the winter, and getting a product equal to four quarts per diem, and he says she gained in condition all the time. Col. Potter, of Potters Corners, Crawford Co., Pa., informed me a short time since, that in fattening two beeves a few winters since, he began by feeding corn in the ear. Noticing whole kernels in the manure dropped, he turned a couple of small pigs into the stable, to get their living from the droppings of his beeves. He afterwards fed meal in large quantities, and the pigs appeared to thrive better than before; but finding that his cattle did not gain very fast, he reduced the quantity of meal fed until the pigs began to squeal for want of food; but, said he, "my beeves laid on flesh and fat much better than when fed in such liberal quantities."

My own experience teaches me that if, in cows of ordinary size, more than, say from three pints to two quarts is fed at one time, waste ensues. That if more is to be fed for the purpose of laying on flesh and fat, the feeding should be, if fed clear, once in six or eight hours, in such quantities as could be assimilated; that if fed immediately before or after the feeding of hay, in any con-

siderable quantities, a loss ensues from the causes already considered, viz., a want of capacity in the animal to digest only a limited quantity in a given time. In other words, the hay being fed at the same time as the meal, or closely in connection with it, the animal after eating its hay, commences remastication; and the meal having at once passed into the fourth, or true digestive stomach, the hay food is thus forced where it is not required, and an over supply ensues. Which is wasted, hay or meal, it is not worth while, in this connection, to inquire; but one or the other, more likely a portion of both, are forced through the system with the excrements.

Mr. Stewart, of the *Live Stock Journal*, has hit, in his late experiments and researches in meal feeding, upon the only safe expedient for feeding hay and meal in connection, which is to cut and steam the hay, and mix the meal with it. Adhering to the hay, it passes at once along with it into the first stomach, and in small quantities through all of them, into the fourth. Thus the animal receives it in small quantities; and if the mass is not, by the mixture, rendered too nutritious for its digestive capacity, no loss can ensue. This can be determined by a careful analysis of the manure, solid and liquid. For the production of milk, this feeding might prove economical. The hay being thereby rendered more palatable, the animal would certainly be inclined to eat liberally, and to remasticate thoroughly; but I can conceive of no additional value rendered to the meal itself, by its passage through all the stomachs.

It might also be practiced to advantage in fattening cattle. If the hay was simply wet, the result, as far as the passage of the meal is concerned, would be the same as if steamed. That there is economy in cutting and steaming hay is self evident. It has been claimed by able men without being questioned, that nineteen pounds cut hay, in

pieces two inches long, is equivalent to twenty-five pounds uncut hay. No nutriment is added by cutting ; but so much less work is to be done by the animal, which requires a certain amount of vital force to perform it. This vital force, when used, consumes a corresponding per cent. of the nutriment eaten. Therefore a less quantity of food suffices if the hay is cut. If it could, by mechanical means, be ground as fine as the stomachs of the animals grind it, the saving would be in proportion, and probably would not be less than fifty per cent. But the hay thus ground would pass directly to the fourth stomach, the same as meal.

Why would not this ground hay be a natural food for the cow? It would go just where the cow's Creator designed it should.

Steaming is a step in the same direction, and in some respects its effects would be more advantageous : as, softening the woody fibre, dissolving the soluble parts, and rendering true digestion more easy and thorough. A saving of thirty per cent. is claimed by this process. As no nutriment can be added, the saving must be chiefly in mechanical force. These considerations lead us to the question of equivalents, in the matter of meal *versus* hay. A common sized animal consumes daily three quarts of the former, or twenty pounds of the latter. In the first the *miller* does the mechanical work ; in the latter the *cow*. The miller exacts a tenth toll for grinding your meal, but the cow is obliged to take more than *one-half* for the labor which she performs on your hay! The constituents of meal and hay, when contrasted as equivalents, are liable to more or less error in results, from the fact that the composition of both vary, different kinds of corn yielding different quantities of any given constituents; some being much richer than others, especially in oil, starch, and sugar; while hay also varies, accord-

ing to the soil upon which it is grown, the time of cutting, and the manner of curing; but we are able, nevertheless, to approximate results.

One analysis by Dr. Salisbury, of Albany, of corn, gave as follows.

Gluten	4.62
Albumen	2.64
Starch	41.85
Oil	3.88
Caseine	1.32
Dextrine	5.40
Fibre	21.36
Sugar and Extract	10.00
Water	10.00

Or, in other words, of nitrogenous or flesh forming substances about 13.00

Of non-nitrogenous or fat producing substances 69.00

This analysis is perhaps as favorable for arriving at an average of the true value of corn for feeding to animals, as any that can be found, except that the amount of woody fibre given is very large.

The result of an analysis of Timothy hay, which is quite as favorable as any I have been able to find, I give as follows:

Water	14.61
Flesh producing or nitrogenized substances	8.44
Fat producing or non-nitrogenized substances	43.63
Woody fibre	27.16
Ash	6.15

We find there spiratory elements, starch, sugar, etc., an excess of which goes to the production of fat in the animal in much larger quantity in the corn than hay. In considering the doctrine of equivalents in this case, we must look beyond these figures, and take into account the difference in the wants and absolute requirements of the

animal upon these different diets. In feeding meal the animal has the three quarts of meal, when introduced to her stomach, to raise to the temperature of animal heat, and say two gallons cold water, per day. This is higher as to water than cattle on meal will average ; but I find myself in a situation to be generous in estimates. In feeding hay, twenty pounds per diem, and at least twelve gallons cold water, are to be raised to the temperature of animal heat, and kept there; and not only this, but her first stomach is filled with the food of several days, weighing from 200 to 300 lbs., according to size of animal, which is also to be kept at the same temperature for the 24 hours, wholly at the expense of the 20 lbs. of hay, excepting what heat may be produced by the slight fermentation of the food in that receptacle.

In feeding hay, she must use up from fifty to sixty per cent. of the nutritious elements in her food, to perform the labor of mastication, remastication, etc., carrying so much extra weight in her stomach, and supplying the extra heat.

In feeding meal, the teeth and three first stomachs of the animal have perfect rest.

In feeding hay, the teeth are in constant use upon tough woody fibre, at least three-fourths of the twenty-four hours, and of necessity wear out much faster than when used on tender grass as in the summer season, or when fed upon exclusive meal diet. The three stomachs, likewise, have a correspondingly tough job in performing their functions.

But why weary your patience by pursuing this subject further ?

Gentlemen, I have proved to you on paper, just as I have demonstrated by my practices, at various intervals for sixteen years, that three quarts of good Indian meal, fed under given conditions, are more than an equivalent

for all the good hay you can coax a cow to eat! I am aware that the best known recognized authorities of the world are against me. Galileo's doctrines were not more radical to his contemporaries, than mine are to-day upon this subject; nevertheless, he was right and they were wrong. Theories are sublime fallacies in the history of our race. Guessing, and taking the most important things for granted, has been our bane throughout all the ages. But tests don't lie, and theories have to vanish before them. I quote here from "Milch Cows and Dairy Farming," by Charles L. Flint.

"Now, the normal functions of the digestive organs not only depend on the condition of its food, but on its volume. The volume, or the bulk of the food, contributes to the healthy activity of the digestive organs, by exercising a stimulative effect on the nerves which govern them. Thus the whole organization of ruminating animals necessitates the supply of bulky food to keep the animal in good condition."

The idea is not original with Mr. Flint, who is excellent authority upon many of the subjects upon which he treats, but it has long been taught as an axiom by the very highest authorities. A greater fallacy could not easily be invented. Force an animal to grind up a great bulk of wood fibre, and carry it about with her, to stimulate the nerves of the digestive organs! Why, every motion she makes, outward or inward, is at an expense of vital force, which is generated by nutriment, not bulk! Alas! poor ruminant; you must chew all day, and you must chew all night, to stimulate the nerves of your digestive organs! Nature cries out in vain for rest and recuperation! Your lord and master says, chew! chew to stimulate your nerves: Nature cries out for nutrition to stimulate your whole system; but man, your lord, gives you woody fibre, bulk, work!

Dairymen, give all the rest you can to your cow, all the year round. When she is in milk if you feed hay, cut and steam and mix a little meal with it if you can ; but give her quiet ; when you feed green grass in the summer months, cut and carry her food to her in her stall if you can, if you want the greatest possible amount of milk from a given amount of food. If your pastures are short, feed her two quarts of meal in the morning, and let her stand in her stall until it is digested ; then turn her out. When she is dry, save your hay for the milking season ; fasten her up in a warm, well ventilated stable, and keep her there ; give her from one to two quarts of meal (according to her size and richness of meal) at regular hours morning and evening, and a little salt, after the meal, once in two or three days. Carry her what water she will drink (which will be but little); curry her at least once a day. If she is in poor flesh give her a little extra oil meal at noon; do this and she will look a little gaunt and shrunk behind; but stand and look her in the face, which never deceives, and you will see a bright eye, with no hunger in it, and a placid, contented countenance ; and when you turn away she will not bawl after you, asking in her dumb way for woody fibre, to grind through her system ; do this and she will give you a better return in milk, when you turn her out to grass, than the cow did before, wintered on hay.

Plant more corn, feed more meal, and instead of diminishing your herd gradually, as in the years that are passed away, you may, in the years to come, increase their number.

A new and better era is dawning upon us. The days of famine prices for hay have already passed away, never to return. Let us hasten to learn lessons of wisdom from the errors of the past ; let us study the nature and wants of our animals, questioning all theories, demanding de-

monstration by tests that cannot deceive us ; let us acquire new and valuable skill in the manipulations of our milk products, in the manufacture of both butter and cheese ; let us educate our sons and daughters to make dairying what its importance demands—a science ; let us agitate for experimental stations or farms, which alone can lift agriculture, in all its branches, from its past low estate to the very front rank of all known sciences, where it rightly belongs.

Finally, let us prove all things, holding fast only that which is good.

ADDENDA.

Containing Rules and Explanations, for the Practical Application of the Principles Involved in the Foregoing Address.

FOR AN EXCLUSIVE MEAL DIET.

The stables should be warm and comfortable, securing protection from the rigors of winter. Light and air should be freely admitted when the temperature will permit; sunlight should never be excluded from our animals, unless it involves the admission of cold winds. The platform upon which they stand should be dry, and if covered with refuse straw, or forest leaves, gathered for the purpose, it will add to their comfort, securing better results for the food consumed, and a valuable addition to the manure pile. Dairy cows should be first

DRIED OFF.

before they are restricted to the limited quantity of food recommended. If any of the herd are to be kept in milk, they should be placed by themselves, and out of sight of the others if practicable, and fed accordingly upon both hay and meal, or other coarse succulent food. If however coarse food is wanting, and milk is desired, the animals may all stand together as usual, and those in milk fed according to directions given.

OVER FEEDING

is to be guarded against as indispensable to success. The mangers or troughs, in which the animals are to be fed, must be arranged so as to render it impossible for

any of them to obtain, by overreaching, any part of the portion fed to their nearest neighbor. Feeding troughs are not a necessity in meal feeding. The mess may be eaten from the smooth floor, in front of the animal, or any convenient vessel, movable or otherwise; but as some will eat faster than others, they will infringe upon their neighbors' rights, unless prevented by a partition which renders it impossible. The usual distance between the stanchions in the common American stable where hay is fed, is not sufficient, without partition or other effective barrier. The damage to the animal robbed of a portion of its daily ration, bears no proportion to the injury inflicted upon the trespasser. Scouring, which is most zealously to be guarded against, is sure to result if overreaching is practiced.

THE MEAL

must be ground as fine as possible. Scouring is liable, if it is fed coarse. The gastric juices perform their work upon fine meal readily; and if the quantity fed at one time is not too large, not a particle can escape their action. If coarse meal is, from necessity, fed, it should be thoroughly cooked or steamed, which alone would render it equal to fine. In case it was desired to lay on flesh or fat, either to improve general condition, or to make beef, the quantity might be gradually increased, if cooked, with but little, if any, danger of relaxation of the bowels. The corn used [should be of the yellow variety, unless

OIL CAKE OR COTTON SEED MEAL

is added. There should be from three to four per cent. of oil in good sound yellow corn (white corn although it may be rich in starch and sugar seldom contains even one per cent. of oil). This proportion of oil in their food should never, under any circumstances, be dimin-

ished, but may with safety be increased fifty per cent.; and if beef is desired, the quantity may be doubled. The feeding should be at

REGULAR HOURS

if possible. Habit governs the appetite and wants of the animal, to a much greater extent than is generally understood. Quiet, which is essential, if the best results are desired from a given amount of food, can never be secured unless the hours of feeding are regular and uniform. Twice a day, not far from sunrise and sunset, with an average of about three pints to one feed, has been the author's rule; but, if convenient, dividing the meal into three messes instead, might insure better digestion with some animals, and also obviate some of the dangers of relaxation. As a rule, the meal when fed to cows *not in milk* should be

DRY.

The animal has an abundance of saliva, which is better than water to moisten it, and which otherwise will be partially wasted. This also insures a slower passage of the meal into the stomach. Any device, by which the time of eating could be lengthened, without diluting the food, would insure a more perfect digestion; but it should be understood that diluting food renders digestion more slow, difficult, and uncertain. The dryer the food, the longer will be the process of moistening it with the secretions of saliva. As these secretions are natural, the presumption is, that their agency in preparing the food for the action of the gastric juices, and other acids employed in the different stages of digestion and assimilation, may be essential. As over-feeding is most rigidly to be guarded against, an

EXACT MEASURE,

holding three pints (if feeding is to be twice a day, or

one quart if three times) should be used, that no mistakes may occur. It cannot be impressed too strongly upon the mind, that success in meal feeding depends more upon this *one little item*, than perhaps many others combined. The meal MUST be fed in *small* quantities. Relaxation, which may prove difficult to control, is sure to follow if due heed is not paid to this point. For the same and other obvious reasons, the feeding should be done, if possible, by

THE SAME HAND

from the beginning to the end ; and this should never, under any circumstances, be left to a careless or incompetent person. The animals will require watching closely, and no one should have charge of them, unless he feels interested in carrying them through in the best possible condition. One ounce of *prevention* will be found of far greater value than a *pound* of cure, in feeding meal.

THE CHANGE

from coarse food to fine, had better be made at once, without any gradations. It takes a number of days for the first stomach to become quite empty, and remastication of the coarse food previously eaten will continue more or less until this is accomplished. The meal fed goes at once to the fourth stomach, and if the quantity for the first two or three feedings is not small, an over supply ensues; at all events it is mixed with the coarse food previously eaten, until the supply runs out. For this reason the change cannot be made suddenly, if it was desired, and the feeder must use his judgment at first, rather than his measure. Besides, if the animal is unaccustomed to eating meal, three pints would be likely to produce satiety at first, even if it did not affect the bowels unfavorably.

The absence of the weight and bulk of the coarse food, and the necessary gradual cessation of rumination, involves more or less uneasiness, on the part of the animal, for a few days. It is simply, however, the breaking up of an old habit, and the formation of a new one in its place; and perfectly in accordance with nature, and the laws designed for the well-being of ruminants. The wonderful provision for the passage of fine food direct to the fourth stomach, is of itself a full and complete answer to any and every assertion and argument, that meal is an unnatural food; or that its exclusive use involves any actual suffering whatever. The animals had better be kept in their stalls, and watered by hand, until they become quiet and contented. If accustomed to the change of diet, they accept the situation very quietly. The present winter (1875) a stranger daily visiting the stables of the writer, would scarcely have noticed anything unusual in the appearance of his herd, when the change of diet was being made, unless it was the natural shrinkage in bulk. This shrinkage soon becomes marked and prominent, and, to one unaccustomed to seeing animals in that condition, might cause him to regard them as wasted and poor, when in reality they were the reverse. The animal, relieved from carrying a large bulk of matter (amounting in an aggregate to from one-fourth to one-third of her live weight) and the by no means insignificant labor of remastication, soon learns to enjoy her new life. The old habit might incline her to seek bulky food, if she had the chance, but the better way is to keep such food out of her reach, compelling the formation of new habits in accordance with her changed condition. The same hand that feeds the meal should

CLEAN THE STABLES,

or at least examine the manure of each animal as often

as he feeds. This he should never neglect, until his animals have become accustomed to the new diet, and their discharges become natural, showing regularity and perfect digestion. Upon his care and discrimination in this matter will depend his success in meal feeding. The manure dropped for the first few days will vary more or less, being composed, in part, of the contents of the coarse food previously stored in the rouen. If any tendency to relaxation is shown, scald the meal, or lessen the amount fed. When the old food has been evacuated some animals will go one, two, and even three days without dropping any manure whatever. This is no cause for alarm, but is an indication, if the appetite is good, that the ration of meal may with safety be slightly increased. If however the appetite is poor, and a reluctance is shown to eating, try if scalding the meal will not better meet the requirements of the animal's taste. No harm will ensue if the ration is withheld for one or two feedings, or even more. It is always safe to underfeed, but *never to overfeed.* In nine cases out of ten, they will resume eating their rations when they get ready, and appear to be better for the season of *fasting.* If, however, the case is obstinate, a tablespoonful of copperas may be dissolved, and poured down the throat. A marked difference will be observed in the appetites of a herd of cows for this diet, which generally, but not always, conform to their

DIGESTIVE CAPACITY;

that is, those that eat meal with the greatest avidity, are generally able to digest their rations thoroughly. Again, as a rule the best milkers will be found to be the greatest eaters, but in this there are exceptions. The animals being dry, the mammary glands are at rest, unless, indeed, they have the power to lay up stores of fat, to

be used afterwards in the production of rich milk. The animal having become accustomed to a meal diet, which will be shown by the regularity of its daily evacuations, it becomes important to learn its actual digestive capacity, which may always be done, by closely watching the manure dropped, and conforming the amount of the ration to its distinctive characteristics. When, as will frequently be the case in a herd of cows thus fed, the manure assumes a whitish mealy appearance, and is soft and watery, the rations are too large, and should be gradually shortened until the desired condition of the droppings is reached, which should be about *three* (3) evacuations daily, of the color and consistency of ordinary winter manure. If

COSTIVENESS

ensues upon the feeding of a given ration to an animal, the manure will be rarely dropped, and always hard, dark colored, and expelled in small round balls. In such cases the amount of the ration should be gradually increased, until the desired regularity and consistency is reached. This condition however is sometimes occasioned by want of exercise, and care should be used in increasing the ration of meal. One half hour each day, when it is ordinary winter weather, for drinking and outdoor exercise, will obviate costiveness from sedentary habits. If the animal can be thoroughly curried daily, and watered in the stable, the effect of the food eaten will be much more satisfactory than if allowed to run out in the cold for a longer period. In case, from any cause whatever,

SCOURING

actually sets in, the ration should be withheld, or the meal thoroughly cooked; and this should be persisted in until the bowels become regular. If the case is obstinate,

feeding scalded milk is one of the safest remedies known. The juice of hemlock bark boiled until strong, or of the root of the common sumac, is sometimes used with success. The animal loses flesh very fast when in this condition: and no pains should be spared, either to save her from getting into it, or curing her at once, when unfortunately in. Some cows will digest much more meal than others of the same size, and a ration that would cause costiveness in the one, might prove the occasion of scouring in the other; but such are extreme cases, and rarely occur. A perfectly safe remedy when an animal is found incapable of eating, without scouring, is to

SCALD THE MEAL,

and persist in the practice, increasing the quantity until her wants are fully satisfied, and improvement in condition is manifest. He who feeds meal intelligently, will soon learn, that each of his animals has a capacity of her own for the digestion of her food, which is irrespective of size, weight, or general condition as to flesh; and to this he must conform; and he will find the amount required to meet their wants can be determined by no fixed rule, but is learned by close observation. Digestion, and the assimilation of the elements of food, are mysteries which science has never as yet been able to unfold. Unseen and invisible agencies silently work out their mission, under the fixed and uniform laws of nature, within all living beings. If we knew all the mysteries of digestion, it would enable us almost to baffle death itself, in the human family, prolonging our lives beyond the limits of the patriarchal age; and empower us to make greater improvements in our domestic animals than the wildest visionaries (*generally falsely so called*) have ever dared to predict. Science is gradually but surely working out the great problem. Professor L. B. Arnold, who

needs no eulogy from me, for all his writings and works praise him, under date of February 4, 1875, writes me as follows :

"Analysis of the various digestive juices is of little account. The recent investigations in the physiology of digestion, in which I have taken an active part, show that all the changes involved in digestion are of a fermentative character ; *i. e.*, they are carried on by the action of ferments, and chemists in analyzing the juice invariably kill the ferment, and thus put out of sight the very thing they are looking for.

"It has recently been proved, that saliva acts as a yeast, and multiplies its power the same as any other leaven. . . . . I have fully demonstrated, that gastric juice acts also as a yeast, and that the ferment may be multiplied and carried from day to day, as a housewife continues her yeast : and have also done the same with sections of the intestines and bladder. The efficacy of the pancreatic juice lies also in a ferment, the power of which is capable of being extended from batch to batch ; that is to say, a certain quantity of pancreatic juice is capable, in a given time, of converting a given amount of starch into sugar ; and after having done this (all it was capable of doing in a given time), it can then be used again to convert another portion of starch into sugar in an equal length of time."

This limit to the capacity of the digestive organs and agencies should always be borne in mind, in feeding concentrated food ; which passes at once in a mass into the fourth stomach, and immediately becomes subject to the action of the various digestive juices and secretions. In the remastication of coarse food, nature provides a feeder, which is never at fault in this respect at least, for the food passes in small quantities, under the action of the digestive juices : coarse food also lies in the first

stomach or rouen for days, before it is remasticated ; and without doubt, becomes partially fermented prior to its passage into the region of the digestive secretions ; but no such fermentation can take place with the meal, and the quantity fed at one time must be small if waste is to be avoided.

IN FEEDING FOR FATTENING

this should be borne in mind. The large quantities of concentrated food usually fed must of necessity be in a great measure lost. Not over two quarts of such food should ever be given at one time, and three feedings in twenty-four hours, if coarse food is given also, would certainly be the full extent of almost any animal's digestive capacity. It is impossible, if coarse food is given liberally, to prevent a waste of meal unless the quantity is small. In wintering

YOUNG STOCK CALVES, ETC.,

it is a question to be determined by long experience, whether an exclusive meal diet would be advantageous to the full development of the three first stomachs of the animal. Ordinarily, if any organ is not in use, it ceases to develop and grow, and it may be found that young stock, which have not arrived at maturity, will have small and defective stomachs, as far as capacity to hold a large quantity of coarse food is concerned, if fed for any considerable length of time on clear meal. A portion of meal daily, and a ration of coarse food, would seem to be safer ; but actual tests are better than theories. In changing

FROM MEAL TO HAY,

which should always be done if possible with dairy cows, when they commence making bag, it is desirable to do it gradually. The conditions are reversed from what they

were in the stomachs of the animal, when the change was made from hay to meal. Then the rouen was full, but now it is empty. It has been the experience of the writer, that animals once accustomed to meal diet, greatly prefer it ; at any rate they generally refuse coarse food at first, and the very best of fresh hay has little power to tempt the appetite. It takes days, more or less (according to size and appetite of the animal), to fill the first stomach so that she will commence remastication. Unless a portion of meal was fed during this period, hunger and suffering must of necessity ensue, for there is positively no digestion and assimilation of the food while it is in the first stomach and previous to the resumption of remastication. Wetting the hay with a little brine, or steaming it, might tempt the appetite of the animal to resume the discarded habit of *going to work* upon coarse food. Care should also be taken to feed all the salt that an animal will eat with relish, while this change is going on, and this should always be done summer and winter. If she is fed daily with a portion of meal, that will be evacuated as before the change; but no hay manure can be dropped until after rumination has been begun, and the food has had time to pass through all its accustomed stages. When the cow drops her calf, if, as is sometimes the case, hay or coarse food cannot be obtained, the animal can be kept entirely upon meal, even while giving milk; but it is to be justified alone upon the plea of necessity, and practiced with caution. Generous feeding of all the nutritious and succulent food which she can be induced to eat, should be the rule, after three or four days from pasturition. It will be found that she will bear from five to six quarts meal daily under her changed conditions, without causing scouring, and it may be even more ; but it might be advisable to wet or scald it. The mammary glands, which were dormant before, now act

with renewed force and activity ; this activity gradually diminishes as the months roll on. The flow of milk will not be large upon clear meal, but its quality will be excellent; and if made into butter, the amount from a given quantity will be satisfactory. It has been the invariable experience of the author, that cows wintered in this manner yield a larger

FLOW OF MILK

when turned out to grass, than when wintered in the usual manner upon hay and ordinary coarse food. The reasons for this result he does not venture to give, as they would be only his opinions founded upon theory, but the fact is indisputable. Another sequence he has noticed, which is a remarkable tendency

TO LAY ON FLESH.

This is so marked, that the past season some of his cows, giving a good flow of milk, have been fit for the butcher as early as the month of August ; a circumstance which he certainly never knew to occur with cows in milk, which were wintered on hay. The dairyman not unfrequently has in his herd cows that have an exceptional value, either as great milkers, or as giving milk of peculiar richness and color, and which are very valuable in giving tone and color to his whole dairy product. The usefulness of such cows

CAN BE PROLONGED,

even after their teeth begin to fail, by feeding more meal during the winter months and less coarse food. Hay, corn fodder, and all kinds of straw, no matter how early cut, or how carefully cured, has a coating of hard woody fibre, requiring *good teeth* for mastication and remastication. If such food is given to an animal with poor teeth, it will be found impossible for her to thrive, and lay on

flesh ; but if thoroughly steamed and cooked, the case is different; it being by the process rendered fully equal in digestibility to the young and tender grasses of the pasture. But, where steaming is impracticable, Indian meal (cooking will not hurt it), oatmeal, bran, brewers' grains, linseed oil cake,or cotton-seed meal, fed in suitable combinations in suitable quantities, may take the place of all coarse food; and the animal kept much longer than is possible on hay and the usual treatment. Such animals should have meal all the year round. A vast amount of food is lost, except as manure, every winter, by

OVER FEEDING

for the production of milk, to supply our villages, large towns, and cities, throughout the country. Milk in the winter, and early beef in the spring, always command a high price, and *springers* and farrow cows, are bought up in the fall, and fed with this double object in view. As a rule, this class of feeders lose sight of the great fact, that there is a limit to the digestive capacity of their animals ; and in their eagerness to produce both milk and beef at the same time, overcrowd the fourth stomach and intestines with a larger amount of nutrition than can possibly be assimilated within a given time. If fine food, like coarse, went into the first stomach, the loss would be less, for it would have to pass, in small quantities, through the whole process of digestion. If the animal is given all the coarse food it will eat, and that of a very nutritious quality, remastication will nearly furnish all the material that the digestive organs and juices can handle, the system being clogged with a large amount of worthless matter which has to be expelled. Adding to this from four to six and even eight quarts of rich Indian meal at a single feed, to go at once into the fourth stomach and intestines in one mass, not only insures a

great waste in material, but has a tendency to surfeit and sicken, in some cases, the animal. Less coarse food and much less fine, the latter to be given at intervals as far as possible between the feedings of the coarse, will be found to produce more milk and beef, and of a better quality, than can possibly be obtained by the *crowding process.* Whenever, and wherever, there is much scouring, there will be great loss. Whenever meal of any kind, or any kind of food which from its nature and condition passes direct into the fourth stomach, is fed, it is all important that it should be as FINE as possible. If fed dry, it is moistened with saliva and passed in smaller quantities into the stomach than if fed wet; but if scalded or cooked, and allowed to stand until fermentation begins, digestion will be thereby assisted.

For the production of rich milk and butter of superior quality, Indian meal is invaluable to the dairyman; but when he is enabled by its use, to laugh at the calamity of short and defective hay crops, and to use it as a substitute for coarse food under all contingencies, the chief uncertainties and discouragements of his business are overcome; for corn is the most certain crop of our country and seldom fails. Judicious feeding of dairy stock, both while dry and in milk, as well as for the production of beef, will, when practiced, greatly enhance its value. That these pages may contribute to such a result is the earnest wish of the author.

Since writing the above, letters of inquiry have been received from various parties in different sections of the United States, asking for information upon some points not treated distinctly under the foregoing heads, which I herewith answer to the best of my ability.

THE SENSATION OF HUNGER

cannot arise from the absence of coarse bulky food in the

first stomach. It is only nature crying out for nutrition. Whenever the organs and agencies of digestion, in the fourth stomach, bowels, etc., have exhausted the elementary constituents of the food last eaten, by carrying them to such parts of the body as are in want, if there is any deficiency in the supplies, a craving arises for more, and this is *hunger*. The distension of the first, second, and third stomachs and their use and activity are only requisite when coarse food is eaten, and are not required when meal is fed. There is no danger in the

HEATING PROPERTIES OF MEAL,

fed as an exclusive diet, in the small quantities recommended. If fed in larger quantities, and by being mixed with cut and steamed food, forced, against nature, into the first stomach, instead of the fourth, where it belongs, overheating would be liable to arise, as the food, once taken in these, must lay for days, and take its turn in passing out. The "very little" water drunk, when on an exclusive meal diet, demonstrates, that there is no unnatural or dangerous heat generated. I am asked by "one almost persuaded," if it would not be better to feed three or four pounds of

HAY

along with the meal, even if the quantity of meal was reduced? Possibly it might be, but I think not, and I give my reasons as follows: A small quantity of hay, or any other coarse food, which forces its way into the first and through all the stomachs, would only keep up the old habits, which it is desirable to break off. There might not be any loss of food, if this small quantity was given in connection with a small amount of meal, but there would be a great loss of *quiet;* and thus a larger amount of food would be required, to keep the animal in a given condition as to flesh. Another asks, if it would

not be better to cut and steam five pounds of hay, mixing the meal with it, and

FEEDING THE MIXTURE TOGETHER?

To which I reply: I can only theorize, never having tested it; but my judgment would tell me, that if large quantities of hay and meal were to be fed, for the purpose of getting a large flow of milk, or of fattening an animal, or both, this might be advantageous. Mr. Stewart, of the Buffalo *Live Stock Journal*, is a good authority upon this practice. But if light quantities are to be used, I should certainly prefer clear meal. The feeding of meal alone is just as

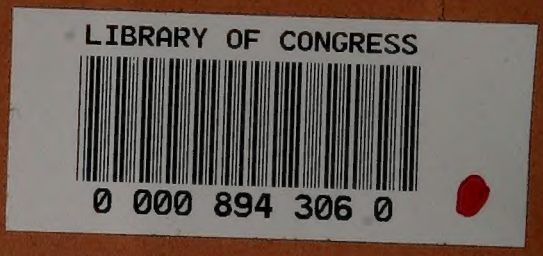
NATURAL

as feeding hay or other coarse food alone. Both go where nature designed they should. It would seem almost impossible that meal, when swallowed, should pass by the large opening, or passage, into the third stomach. But as it is not required there for any purpose whatever, the animal has the power (which must be involuntary) given it of contracting that opening, and forcing the meal past into the fourth or true digestive stomach, for which it is prepared in grinding by the miller. How then can it be an *unnatural* food?

FEEDING MEAL ALONE

is just as safe as feeding coarse food alone, if proper care is taken to observe the rules laid down in this work.

It is the author's intention to continue his experiments in meal feeding, collecting and publishing all possible reliable information and data upon the subject; making a work that shall grow in future editions into a larger volume; and which shall be an invaluable text book to all who feed ruminants. Any information of results from those who follow this practice will be gratefully received and duly credited.



DESIGN OF CREATION.

The author, after years of thought and investigation on the subject of the "Creation," has issued a pamphlet, with the above title, containing his views and the conclusions derived from those investigations.

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